DISTRIBUTION SYSTEM FROM MAIN SOUTH SIDE CANAL.

The new lands served directly by the Main South Side Canal total approximately 108,400 acres, about 30,000 acres of which lie under the Ridenbaugh Canal. This distribution system is in condition to supply water to about 70 per cent of the lands under it.

DEER FLAT RESERVOIR.

The Deer Flat reservoir lies in a natural depression situated southwest of Nampa and has a capacity, as now constructed, of 186,000 acre-feet of water, 170,000 of which are available for irrigation and submerges an area of approximately 9,250 acres. It is controlled by two large earthen embankments already constructed and a small embankment and dike yet to be built. The upper Deer Flat embankment, located 4 miles west of Nampa, has a maximum height of 70 feet, a length of crest of 4,000 feet, and contains approximately 932,200 cubic yards of material. This work was done by force account, having been begun in 1906 and finished in 1908. Owing to the appearance of seepage water below the upper Deer Flat embankment, improvements were begun on this structure on June 4, 1909. These improvements consisted of placing a suitably drained gravel blanket, about 200 feet wide and 1,000 feet long, over the area immediately below the embankment, driving the sheet piling along the lower edge of this blanket and installing a drain beneath this blanket immediately above the line of piling for conducting the accumulated seepage water into an open drain. These improvements were completed during August, 1909. It is proposed yet to place additional protection on the water slope against wave action. The lower Deer Flat embankment, situated 5 miles south and 2 miles west of Caldwell, has a maximum height of 40 feet, a length of crest of 7,200 feet, and contains approximately 936,600 cubic yards of material. This embankment was constructed by contract by Hubbard & Carlson. It was begun in 1906 and completed in the spring of 1908. Additional protection on the water slope against wave action is also to be provided for this embankment.

DISTRIBUTION SYSTEM FROM DEER FLAT RESERVOIR.

The canal system from the Deer Flat reservoir may be separated into canals drawing water from the reservoir at the upper Deer Flat embankment and that drawing water therefrom at the lower Deer Flat embankment. The canals from the upper embankment cover approximately 6,600 acres of new land, and the larger of the two canals is designed to supply the Pioneer Irrigation District, containing about 36,000 acres of land, with stored water during the latter part of the irrigation season. The Deer Flat Low Line Canal, taking water from the reservoir at the lower Deer Flat embankment, covers approximately 49,000 acres of land lying south and west of Caldwell and has a total length of 35 miles. Of the area of new lands served by the Deer Flat reservoir about 45 per cent are in condition to receive water at the present time.

TELEPHONE SYSTEM.

Work was begun during March, 1910, on a telephone system for use in the operation of the canal system and the main trunk lines of this telephone system are now completed. Contracts were entered into with two private companies, permitting the use of the poles of their systems for the lines of the Reclamation Service. About 110 miles of metallic circuit have been installed on government pole lines and 32 miles of such circuit on the pole lines of private companies. The system, as now constructed, connects the Boise office with the offices of the various water masters and the whole system is about half completed.

SETTLEMENT.

Practically all of the public lands on the project have been entered and nearly all entries have been conformed to farm unit plats. Chances for additional settlers to obtain land, therefore, lie in the subdivision and disposal of private holdings and of homestead entries under the assignment law.

OPERATION AND MAINTENANCE.

The canals of the system ready for carrying water were opened during the irrigation season of 1909, and were operated during that season and during the season of 1910. During 1909 water was delivered to approximately 22,000 acres of land, 18,000 of which were old lands lying under the old New York Canal and 4,000 of which were new lands. In 1910 the total area irrigated was approximately 30,000 acres, including the old New York Canal lands and 12,000 acres of new lands. For the condition of the water supply, which is not yet completed, crop yields have been excellent.

FROST PREVENTION WORK IN THE ROGUE RIVER VALLEY, OREG., DURING THE SPRING OF 1910.

By P. J. O'GARA, Scientific Assistant, Fruit-Disease Investigations, Bureau of Plant Industry.

The work of frost prevention during the past season of spring frosts has been carried on most successfully. The scope of the work has been such as to include practically all the better orchards lying on the valley floor, and the demonstrations can not be considered in any other light than being entirely practical. The experimental work carried on in only a few orchards three seasons ago has been taken up and extended so that at this time it is believed that the matter of frost prevention in the orchards of the Rogue River Valley is a settled problem. During the past season there were just a few orchards in the danger zone carelessly left without protection; luckily these have served as a check on our work. In every case the unprotected orchards lying within the frost zone were badly damaged, and, in some cases, the crop entirely destroyed, while the protected orchards did not show a frost mark or ring on any of the fruit.

During the past season much valuable data have been secured, especially in the matter of orchard fuels and appliances to be used in frost prevention. As in the past two years' work, wood and coal have proven entirely satisfactory, but somewhat cumbersome and difficult to handle. Besides, the wood piles in the orchards have been more or less in the way, making it somewhat difficult to cultivate or work the soil. The same may be said in regard to spraying or carrying on any other orchard work. However, these materials have proven so satisfactory to those who have used them during the past three seasons that they seem willing to accept the difficulties occasioned by their use and will continue using them in the future. To Mr. J. G. Gore should belong the credit of first using wood successfully as a fuel for orchard firing in the Rogue River Valley. During the past three seasons Mr. Gore has saved a pear crop on his 7½-acre Bartlett pear orchard. His first firing was done with old rails which he took from an old fence surrounding the orchard. Later he used cord wood with equal success. The crops harvested during the past three years have been unusually clean, free from all frost marks and very heavy. The trees are about 21 years old at this time, and the average annual crop for the past three seasons has been approximately twelve carloads. His results are in striking contrast with those who failed to protect their orchards which are even less exposed than is Mr. Gore's orchard.

Not only has Mr. Gore saved his pear crops, but his apple crops as well, with the exception of the past season when one freeze found him unprepared and he did not have time to distribute fuel in the apple orchard. As a consequence, a large part of the apple orchard failed to set fruit on account of the blossoms being frozen. In this particular case, the apple orchard, which is directly south of the pear orchard, could not be benefited by any firing in the pear orchard, since the slight air movement was from south to north. Mr. Gore has had the opportunity to see the other fuels tested, namely, coal, crude oil, and distillate; but he is of the opinion that wood is to be preferred. A number of other growers share the same opinion and are now preparing for next season's frost fighting campaign.

Crude oil, direct from the California wells, and 28° test distillate have been successfully used. In the past, crude oil was very little used on account of the fact that it was difficult to obtain it sufficiently free from water. However, during this season a very good grade of crude oil, practically free from water, and at a cost of about 4½ cents per gallon laid down, was very largely used in some of the large orchards with entire success. This oil was burned mostly in the Fresno pot, or heater, with about 60 to 70 pots per acre; the actual cost for one night's firing per acre, including the labor necessary to fill the pots, was about $3.00. The crude oil was very easy to handle and was distributed in the orchard by means of a large wagon tank carrying lines of hose. The hose was attached at the rear end of the tank, and the nozzle carried by the laborer. With two men for each tank, two rows of pots could be filled almost as fast as the team could walk with the loaded tank. A record of some of the work of filling the pots was carefully kept, and the average showed that six men could easily fill 2,000 pots in 8 hours. At 60 pots to the acre, this crew would easily handle 33 acres. In handling the crude oil, as little pumping as possible should be done; gravity should be depended upon, not only in filling the pots, but also in filling the wagon tanks.

The 28° test distillate is a much better fuel than the crude oil, but its cost laid down is about double that of crude oil. However, it is a fuel that can be relied upon since it can never contain water. As a matter of fact, if water were poured into it, its specific gravity would cause it to be always on top. Careful tests have shown that, gallon for gallon, it will last longer than crude oil and is not so easily extinguished. It is also easier to light since it volatilizes more readily than crude oil. However, in lighting both these fuels, gasoline should be used.

In lighting crude oil or distillate, the following very simple method has been employed by many of the orchardists: A medium-sized machinist's oil can is filled with gasoline and a few drops are squirted into each pot. A small plumber's torch is fixed to the end of a stick about two feet long, and as the gasoline is squirted into the oil-filled pot, the lighted torch is immediately applied. By this method, fuel pots may be lighted as fast as a man can walk through the orchard.

Mention has been made of the use of wood and coal. Previous to the past season, fine materials, such as shavings and sawdust saturated with crude oil, were used to light the coarse material. However, it has been found that the easiest way to light the wood (preferably heavy sticks since light wood burns too rapidly) is to first place the half dozen sticks for each pile in such a way that the ends dovetail. Then a can of kerosene and a plumber's torch are used to light the wood in much the same way as the gasoline. Sometimes, instead of using a plumber's torch, a large swab, saturated with kerosene and used as a torch, served the purpose very well.

In order to light the coal, which is mined near Medford, Oreg., it was found necessary to employ the coal heaters. In using heaters, a piece of waste, saturated with crude oil, is first put into the bottom, and, on top of this, fine material, such as small sticks of pine or other readily ignitible stuff, is placed. Then about 25 or 30 pounds of broken coal are poured in. In lighting, a torch is applied at the bottom of the heater, the flame passing through the vents and igniting the waste. These heaters are lighted as rapidly as any other fire, but much more time is necessary in preparing them for use.

A large number of practical tests have been made in order to determine the length of time different materials will burn and give the maximum amount of heat to the surrounding atmosphere. Measured gallons of crude oil and distillate, burned both in the Fresno pot and in a common 10-pound lard pail holding a gallon each, were used in the tests. While there was some slight difference in different lots, or samples, the average time taken to burn a gallon of each with the covers or dampers entirely removed was about 4 hours. There seemed to be no difference in the style of pot so far as the time required to burn one gallon nor in the amount of heat given off. The row of holes at the top of the Fresno pot seemed to be of no advantage whatever. The tests under actual service in the orchards showed that a plain sheet-iron pot without any holes or vents would serve every purpose. The charge usually made for the various patent pots runs all the way from 20 to 25 cents or more; while a pot just as good could easily be made for from 6 to 10 cents, depending upon the quality of the sheet iron.

Coal fires in sheet-iron heaters filled with from 25 to 30 pounds of coal easily burned 4 to 6 hours with the damper removed. Wood fires, with about 6 good fir sticks of cord wood, lasted easily 4 to 5 hours. In the burning of cord wood or longer sticks, more attention is necessary in order to get the best results. It is quite necessary to frequently move the sticks forward into the crater of the flame so as to keep them burning. However, knowing the direction from which the slight breeze usually comes, the wood may be so placed as to secure good results with a minimum amount of labor. By cord wood, the 4-foot length is to be understood. The number of fires per acre must necessarily vary between wide limits. In an old orchard, where the trees are large and mostly cover the ground, fewer fires are needed in order to maintain safe temperatures than in an orchard of young trees which only partly shade the ground. Under ordinary conditions, an old orchard with wide spreading branches may be protected from injury even where the temperature goes as low as 20° F., with 60 crude oil, distillate or coal fires per acre. The same orchard can be protected with from 30 to 35 wood fires per acre. Younger orchards under similar conditions of temperature will require at least 70 pots or heaters per acre, and perhaps, 50 wood fires. In case temperatures do not range below 26° F., the number of fires which should be lighted may be proportionately less. The conditions, of course, are so variable that no set rule can be given, and the only thing that can be said is that the one in charge must look after the temperatures in the orchard and start the fires as needed. Usually, only one-half the number of fires should be lighted, and the remaining pots or wood piles should be left as a reserve to be lighted only when the temperature begins to fall below the danger point. It is not well to wait until the temperature has gone much below the danger point, since injury may be done by warming up the frozen blossoms or fruits too suddenly, and thus having the same effect as the sudden warming by the morning sun. Another important factor is the placing of a double number of fires around the outside rows, especially on the sides from which the slight breezes come.

The cost of firing per night per acre depends not only upon the cost of the fuel, but also upon the degree of frost. Under average conditions, say with temperatures of 26° to 27° F., the cost per night per acre with the fires burning 4 hours has been estimated for the past season as follows: Crude oil, including the labor of distributing the oil and interest on the cost of the pots, with 60 pots per acre, $3.00; distillate, including the same items of expense, $6.00; coal, including the same items, $5.00. This is on the basis of 250 pounds of coal per acre hour, the coal being worth $4.00 per ton at the mine. The cost of hauling the coal, as well as the kindling for starting it, is included within the estimate. The cost of firing with wood is very difficult to give since the price of wood varied greatly. However, it would be safe to say that with 30 to 40 fires per acre, under the above conditions, the cost would be from $2.00 to $4.00 per acre. From this it will be seen that crude oil is the cheapest of the fuels, taking everything into consideration, with wood a close second. Distillate is the most expensive; but for liquid fuel it is by far the most reliable. However, when the value of the crop is considered, the above actual costs represent a very cheap insurance.

The value of any fuel for frost prevention depends upon the amount of heat it is capable of giving off. All of the fuels which have been mentioned have proven entirely satisfactory. A careful test of crude oil in the Burrell orchard, at Medford, Oreg., on the night of April 13 and 14, gave the following results in a 30-acre pear orchard, which is about 22 years old, the trees being large and spreading. At 12:00 midnight of the 13th the temperature in the orchard was 36° F.; at 1:00 a. m. of the 14th the temperature dropped to 31° F., when the fires were immediately lighted, and in a short time the temperature in the orchard rose to 33° F. From 2:00 a. m. until 5:00 a. m. the temperature outside the orchard remained approximately 26° F., while the temperature within was held to 36° F., with the exception of the south side, which was not so well protected by fires, and where the temperature along the outside row registered 32° F. The temperature inside the orchard was recorded by a man who had some thirty thermometers which had been previously tested at my laboratory. These thermomters were hung about 3½ to 4 feet from the surface of the ground, being suspended from the branches of the trees. Thermometers were also placed outside the limits of the orchard and well away from any influence of the fires within the orchard. In the above tests, 60 pots were used per acre.

Similar tests were carried out with distillate, wood, and coal, and results equally satisfactory have been gotten. It is not at all difficult to raise the temperature 6° to 10°.

From what has been said it will be seen that the protection of the orchard from frost injury is dependent rather upon heating than the use of the so-called smudge. In our work we have ceased to use the term "smudge," and have substituted the word "heating, or firing," both terms seeming more appropriate. There is only one value in a dense smudge, and that is in cases where it is impossible to keep the temperature above the danger point it will serve to prevent the too sudden warming of the frozen blossoms or fruits when the morning sun strikes them. The smudge may also be more or less effective in trapping any heat generated by fires, or prevent heat from radiating away from the surface of the ground or the trees. However, when the temperature runs very low, the smudge is no protection. Some smudging has been done in the valley, using damp manure, straw, and rubbish, but only in a few instances and where the temperature did not go below 28° F. in the pear and apple orchards.

One of the most important things which the orchardist must know is when to fire. A number of manufacturers have put on the market frost alarm thermometers which may be set to ring an electric bell at any desired temperature. Most of the instruments tested by the writer have been found to be very inaccurate, and in actual use often fail to work. Several instances of failure have been reported, and in one case a considerable amount of fruit was lost through depending upon one of these instruments. At best, all that a frost alarm thermometer can do is to give an alarm when a certain temperature is reached, and it is, therefore, much wiser to use a good alarm clock, and depend upon forecasts from the nearest U. S. Weather Bureau station. In each case a good local observer is the most important factor.

In order to do accurate work and get results all instruments used on the farm should be tested. In my work in the Rogue River Valley I have found thermometers which varied both ways as widely as 3° and 4°. All this had to be corrected, and the growers were forced to get standard instruments, or, at least, have them tested before putting them to use in the orchard. It is a wise plan to use a large number of thermometers, and one per acre is not too many. There are always some spots colder than others in every orchard, and it is only by using a sufficient number of instruments that these spots can be found.

Before any firing is done, some knowledge should be had of injurious temperatures. These temperatures vary quite widely for the different fruits as well as for the different stages of growth. A large series of tests have been made in the Rogue River Valley and upon these tests the following table, giving injurious temperatures in bud, in blossom, in setting fruit and at other times, is appended. Injurious temperatures may not be the same from season to season, as weather conditions previous to frosts determine very largely the ability of plants to resist freezing temperatures. In every case there should be a physiologist on the ground to determine approximately this factor. A few days of very warm weather, together with an ample supply of soil moisture, will cause the newly-formed cells of the blossoms and fruit to be filled with a watery protoplasm, or cell sap, which freezes more readily than concentrated cell sap. If a freeze follows a period of weather in which temperatures have been such as to produce slow growth, lower temperatures than those given in the table may not cause injury.

TABLE 1.—*Temperatures injurious to fruit when in bud, in blossom, etc.*[1]

Fruit.	In bud.	In blossom.	In setting fruit.	At other times.
	° F.	° F.	° F.	° F.
Almonds	28	30	30	28
Apples	27	29	30	25
Apricots	30	31	31	30
Cherries	29	30	30	29
Peaches	29	30	30	28
Pears	28	29	29	28
Plums	30	31	31	29
Prunes	30	31	31	29

DISCUSSION OF WEATHER CONDITIONS IN THE ROGUE RIVER VALLEY.

In the spring months it is found that during the day the wind blows mostly from northerly quarters. These winds are not moisture laden; that is to say, the relative humidity is usually low, often as low as 25 per cent at temperatures of 60° to 70°. During the night, when frosts are likely to occur, the winds die down altogether, or begin to blow slightly from the south. The winds from the south are even drier than the northerly winds and hence the dew-point temperature is usually lower toward morning than that observed in the early evening. Whenever the winds blow from the west or from westerly quarters, it is rare that frosts occur. It is only on the valley floor that any serious injury is liable to be caused by low temperatures during the blooming season or sometime thereafter. Even on the valley floor, where there are some slight elevations, no frosts may occur, while a few feet below, injury may result. The hillsides surrounding the valley usually escape frosts altogether at that period of the year, and it has been found that temperatures range 10° or more higher. All the frosts which occur in the Rogue River Valley are due to depression and lack of air drainage; the cold air coming from the surounding mountains being trapped in the basin. Since freezing temperatures occur simply by the cold air settling in the lower spots in the valley and this air remaining perfectly still, it is evident that there is never any difficulty in maintaining the heat from fires or the smoke from smudges in the orchards. High winds rarely, if ever, occur during the time that the temperature is below the freezing point, and if such did occur, firing would be unnecessary. It has been mentioned before that a slight breeze usually comes up from the south during the early morning. However, this breeze is never sufficient to more than waft the heat and smoke through the orchards, and does not interfere to any great extent in keeping up the temperature. From this it will be seen that the conditions in the valley are ideal for the prevention of frost injury.

[1] These temperatures are approximately those of the air in contact with the fruits and blossoms. It is quite possible, however, that very delicate measurements would indicate somewhat lower temperatures, due to evaporation from the immediate surface of the plant.

During the past three years a very careful study has been made in order to determine some safe method for forecasting freezing temperatures. It is believed that the results of the past season's work, together with other published data,[2] are sufficient evidence that the system used has been successful. Whether or not it may prove so in the future, or whether it may be used in other localities where weather conditions and the topography of the country differ widely from those in the Rogue River Valley, is an interesting problem for future investigation.

It will be seen upon inspecting the records made for the season beginning with March 21 and ending May 22 that there is a relation existing between the dew-point temperature observed in the early evening and the minimum temperature of the following morning. For the Rogue River Valley it has been found that when the atmospheric temperature in the early evening is between 50° and 60° F., the dew-point temperature may be relied upon generally to indicate the minimum morning temperature. It has been found that for such atmospheric temperatures, with clear sky and northerly winds, the minimum temperature to be expected is 3° or 4° below the dew-point temperature as observed. If the daily temperatures have been high and the winds are from the west or westerly quarters, the minimum temperature will always be higher than the observed dew-point. Again, during the latter part of the spring season with long days and a very large amount of insolation, the minimum temperature usually remains the same as the dew-point, or even higher, depending upon the maximum temperature during the day.

Without some study, an inspection of the data in Table 2 would seem to indicate that no close relation exists between the dew-point temperature as obtained in the early evening and the minimum temperature recorded during the night and the morning following. In the early part of the season, from March until about the middle of April, the relation seems more close; but after that time until the latter part of May the rule does not seem to hold. There is a very good reason for this. During the early part of the season, the days were naturally shorter and the daily maximum temperatures were not so high. Hence, the amount of heat absorption by the soil was small in comparison with that absorbed during the latter part of the season. Unfortunately, with no self-registering instrument, the daily temperature curves could not be obtained, and maximum temperatures were not recorded. Had this been done it would be easy to show why forecasts for frost were not made during the latter part of the season, when, according to the rule, frosts should occur. It must be remembered that the relation between the dew-point temperature and the minimum temperature occurring before morning holds good only when the atmospheric temperature at the optimum time for taking the dew-point readings is not far above 50° F. The nearer the atmospheric temperature is to 50° F., at the optimum time of observation, the closer the agreement of the dew-point temperature and the minimum morning temperature. The optimum time, as indicated in the table, is not far from 6:30 p. m., and is for the Rogue River Valley only. It is possible that we may find an earlier hour just as safe, but this must be worked out. Of course, in all local forecasting, an accurate knowledge should be had of general weather conditions as given by the nearest district forecasting station. To rely entirely upon the dew-point apparatus would be a mistake. The movement of the barometer as well as wind directions must play a very important part in making up the forecasts. In all the work done locally by the writer, much assistance has been given by Mr. E. A. Beals, District Forecaster at Portland, and Mr. N. R. Taylor, of the Sacramento Weather Bureau station. These gentlemen have been very kind in offering suggestions and giving advice as to some of the best methods to employ.

The territory covered by local forecasts made at Medford is about 70 miles in length, and includes the districts surrounding the towns of Ashland, Talent, Phoenix, Medford, Central Point, Jacksonville, Eagle Point, Table Rock, Tolo, Gold Hill, Gold Ray, Woodville, Grants Pass, and Merlin. The forecasts were given to the Pacific Telephone and Telegraph Comapny at Medford, a separate sheet being given each operator. Tentative forecasts were given each morning about 9:00 a. m., but the final forecasts were made up at 6:30 p. m. and given to the telephone company at 6:45 p. m. These forecasts were then telephoned to the different towns and stations where they were distributed locally. Instead of calling up the different farmer telephone lines, the subscribers called in for the forecasts, and usually by 7:00 p. m. every grower knew the probable weather conditions which would be expected before morning. It would be difficult to know how many people were served by these forecasts; but in many instances at least five growers used the same telephone, or got the forecasts from the subscriber who owned the telephone. It is estimated that between 1,000 and 1,200 people received the forecasts daily, and this excludes all the small vegetable growers and gardeners within the towns.

The Pacific Telephone and Telegraph Company deserves much praise for the efficiency shown in getting the forecasts distributed. During evenings when it was known that a heavy frost would occur, extra operators were put on, for the purpose of distributing later forcasts which were often given where some slight change occurred and which made it advisable to issue another forecast. This occurred only a few times, and on such nights the extra operators were instructed by the manager, Mr. D. H. Drewery, to be prompt and careful in delivering the forecasts. During the entire season not a single error was made.

The local forecasts, as given in the record book, were delivered word for word to the telephone company, and in most cases the dew-point also was given. This was done because a request was made for the data by a number of growers who had their own psychrometers, made according to the directions given them by the writer. These directions were also accompanied by a dew-point table printed on a card so that those who desired could check their own observations with those given out in the local forecasts. It was with a great deal of pleasure that the writer realized the close approximation made by different growers using home-made apparatus. Any slight difference in the readings could easily have been due to slightly different local conditions of the atmosphere.

It is believed by the writer, as well as the growers, that the Rogue River Valley has not only settled the problem of orchard heating, but also the important matter of accurately forecasting frosts. During the past two years not a single serious error has been made in forecasting. Whether this can be done indefinitely remains to be seen, but the writer believes that it is entirely possible. The writer does not attempt to say that the same methods will apply in other localities having entirely different conditions, but it is believed that for every locality the optimum time for making the forecasts may be found, as well as all the other factors which enter into the problem. This is at least worth a trial.

[2] Farmer's Bulletin 401, U. S. Department of Agriculture, The Protection of Orchards in the Pacific Northwest from Spring Frosts by Means of Fires and Smudges, by P. J. O'Gara, 1910.